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Meeter, M.; Eijsackers, E; Mulder, J

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Retrograde Amnesia for Autobiographical Memories and Public Events in Mild and Moderate Alzheimer's Disease

M. MEETER,[1] E.V. EIJSACKERS,[2] AND J.L. MULDER[3]

[1]Department of Cognitive Psychology, Vrije Universiteit Amsterdam
[2]Department of Psychology, Stichting Zorgkring Westland
[3]Department of Neuropsychology, Leyenburg Ziekenhuis

Patients with mild to moderate Alzheimer's disease and normal controls were tested on two retrograde memory tests, one based on public events, and the other querying autobiographical memory. On both tests, patients showed strong decrements as compared to normal controls, pointing to retrograde amnesia. Evidence for a gradient in retrograde amnesia was conflicted, with analyses of variance revealing no gradient beyond the most recent period, and more sensitive analyses pointing to shallow Ribot gradients on both tests. A literature review shows that this is the case in most published studies. In autobiographical remote memory patients generated many incorrect answers, a tendency correlated with the number of false alarms on an anterograde memory test administered several months earlier. This suggests a stable, possibly executive, factor underlying memory errors.

Introduction

The consolidation theory of remote memory states that long-term memory consists of two distinct stages. Immediately after storage, memories depend for their retrieval on a medial temporal lobe memory system. In the course of time, memories become independent of the medial temporal lobe through consolidation (Alvarez & Squire, 1994; McClelland, McNaughton, & O'Reilly, 1995; Meeter & Murre, 2004, 2005; Squire & Alvarez, 1995; Squire, Cohen, & Nadel, 1984). The main motivation for this theory is the view that medial temporal lobe amnesia consists of two interrelated memory deficits: anterograde amnesia, and a graded retrograde amnesia affecting recent memories more than remote memories. Such a view is consistent with consolidation theory's idea that the medial temporal lobe memory system sustains memory retrieval for only a limited time. Damage to this system would lead to an inability to form new ones (anterograde amnesia), and a loss of recently stored memories (retrograde amnesia). In accordance with Ribot's law (Ribot, 1881) that remote memories are less vulnerable to brain damage than recent ones, remote and already consolidated memories would be spared.

Critics have often charged that consolidation theory is based on a wrong view of the data emerging from the study of amnesia. Nadel and Moscovitch (1997; Nadel, Samsonovitch,

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Address correspondence to M. Meeter, Dept. of Cognitive Psychology, Vrije Universiteit Amsterdam, Vd Boechorststraat 1, 1081 BT Amsterdam, The Netherlands. E-mail: m@meeter.nl

Ryan, & Moscovitch, 2000) have argued that retrograde amnesia after large damage to the medial temporal lobe is typically ungraded, with as much loss of remote memories as of recent memories. Many patients with damage only or mostly in the medial temporal lobe do show a temporal gradient (here referred to as the Ribot gradient) in retrograde memory loss: deficits are more profound on subtests querying more recent memories, and less profound on subtests querying remote memories (Reed & Squire, 1998; Rempel-Clower, Zola, Squire, & Amaral, 1996).

Findings are less clear-cut in studies of neurodegenerative diseases such as Alzheimer's disease (AD). The diffuse lesions in patients with neurodegenerative diseases would argue against drawing conclusions about the medial temporal lobe from studies of these patients. Nevertheless, Deweer, Pillon, Pochon and Dubois (2001) argued that since damage in the early stages is concentrated in the medial temporal regions, such patients may inform us about the role of the medial temporal lobe in memory. In their view, in the early stages Alzheimer's disease (AD) is characterized by episodic memory deficits caused my medial temporal lobe dysfunction. Anterograde memory deficits are indeed among the first signs of the affliction (APA, 1994; Brandt & Rich, 1995; Lambon Ralph et al., 2001; Spaan, 2003; Thompson, Graham, Patterson, Shahakian, & Hodges, 2002), and may predict its progression (Spaan, Raaijmakers, & Jonker, 2003). Anterograde memory is not the only kind of memory that is affected. Patients with AD typically develop retrograde amnesia as indexed by a loss of autobiographical memories (Kopelman, Wilson, & Baddeley, 1989; Piolino et al., 2003), a loss of dated public knowledge (Beatty, Salmon, Butters, Heindel, & Granholm, 1988; Kopelman, 1989; Leplow et al., 1997), and an inability to recognize famous faces (Thompson et al., 2002).

Although the fact that Alzheimer's disease is accompanied by retrograde amnesia is undisputed, the presence or absence of a Ribot gradient in remote memory is still debated. In patients with AD a Ribot gradient has sometimes been found, typically a shallower one than that in other groups (Beatty & Salmon, 1991; Beatty et al., 1988; Brown, 2002; Kopelman, 1989; Kopelman et al., 1989; Meeter, Kollen, & Scheltens, 2005). Other studies with patients with AD, however, found a flat gradient in remote memory loss (Dall'Ora, della Sala, & Spinnler, 1989; Leplow et al., 1997; Wilson, Kasniak, & Fox, 1981), and in several studies some subtests yield a Ribot gradient while others do not (Greene, Hodges, & Baddeley, 1995; Ivanoiu, Cooper, Shanks, & Venneri, 2004; Piolino et al., 2003).

Both reports of Ribot gradients and of flat gradients cannot be taken at face value. A Ribot gradient may reflect the insidious onset of AD: performance on the most recent periods may be worse not because of a true gradient in retrograde amnesia, but because of anterograde amnesia that was already present in those periods. Ribot gradients are therefore most convincing when they exist on the part of the retention curve that excludes the most recent periods (e.g., the last decade for which anterograde amnesia may exist). A finding of a flat gradient, on the other hand, may reflect ceiling or floor effects that can obscure true gradients, or simply a lack of statistical power (a flat gradient is usually the null hypothesis that is tested). Both of these problems can be addressed with a data transformation that translates observed proportions correct to underlying memory intensity, and then expresses performance of the patient group relative to the control group (Murre, Chessa, & Meeter, subm.; Murre, Meeter, & Chessa, in press). This removes the influence of test characteristics from the data, making a gradient in retrograde amnesia less noisy and more easily interpretable. The resultant *relative retrograde gradient* is downward sloping in the case of a Ribot gradient, but flat in patient groups that do not show such gradients (e.g., patients with Parkinson's disease or Huntington's disease, Murre et al., subm.).

In summary, the gradient of retrograde amnesia in AD remains controversial. Consolidation theory suggests that retrograde amnesia is graded in those stages of the disease in which damage is concentrated in the medial temporal lobe, while its critics deny that. Here we investigated this using two separate tests for the assessment of remote memory deficits. We searched for gradients with the traditional analysis, but also by excluding the most recent period to control for possible contamination from anterograde amnesia, and, by calculating a relative retrograde gradient. In the discussion we will return to the conflicting findings in the literature.

Method

Participants

Twenty-one outpatients of the memory clinic of a teaching hospital were included in the study, and were tested from 2001 to 2002. To ensure optimal comparability, spouses of the patients were asked to participate as controls. The patients were selected according to the following criteria:

- medical diagnosis of probable AD according to NINCDS-ADRDA criteria (McKhann et al., 1984).
- mild or moderate AD; patients with more severe AD, scoring below 14 on the Mini-Mental State Examination (MMSE, Folstein, Folstein, & McHugh, 1975), were excluded.
- absence of major depression or psychiatric disorder, as defined by DSM-IV criteria (APA, 1994).
- living with a spouse who was willing to participate.

In addition, the following criteria applied for all participants (patients and their spouses):

- fluency in Dutch
- living continuously in the Netherlands after 1980
- completion of at least primary school (to exclude mental retardation)

Clinical history of patients was reviewed in the medical records. None of the patients had suffered from head injury, alcohol abuse, cerebral vascular incidents, Parkinsonism, depression or other psychiatric disorders at any point in their life. A checklist was administered to spouses to exclude any neurological or psychiatric disorder. They were asked whether they had suffered from the aforementioned diseases as well meningitis and epilepsy.

Spouses were chosen as a control because they could verify the answers on the autobiographical questions through shared life experience. In addition, it is likely that patients shared many life events with their spouses from periods before they were acquainted (by retelling youth stories or showing photo albums). With respect to the public events we expected that both partners had comparable levels of exposure to broadcast news and printed media.

The patient group consisted of 16 males and 5 females with probable Alzheimer disease, aged between 61 and 82 years with a mean age of 73.2 years. The MMSE scores ranged from 16 to 29 (mean 24.5). All patients gave permission for use of scores from their neuropsychological examination in the study. The control group (spouses of patients) consisted of 5 males and 16 females aged between 47 and 85 years with a mean of 71.1 years.

Educational attainment was scored on a seven-point scale, as customary in the Netherlands (Heslinga, van der Burg, & Saan, 1983). The educational level of the AD group was 2.7 (range 1–7) and the educational level of the control group was 2.2 (range 1–6). This is comparable to about 12 years of formal education.

There were no significant differences between the groups with respect to age and educational level.

Materials

All subjects were administered a Dutch version of the Autobiographical Memory Interview (AMI, Kopelman, Wilson, & Baddeley, 1990; Kopelman et al., 1989; Meeter & Murre, 2003), and the Amsterdamse Media Vragenlijst (AMV, Meeter, Klomps, & Borsboom, 2001).

The AMI consists of questions about personal-semantic memories and about autobiographical incidents, which are probed from three periods (Childhood, Early adult life, and Recent life). The personal-semantic questions quiz facts from the past life, relating to childhood (e.g., names of schools or teachers), early adult life (e.g., name of first employer, date and place of wedding), and more recent facts (e.g., holidays, journeys, and previous hospitalizations). Scores of 0, $^1/_2$, 1, 2 or 3 are awarded according to criteria in the manual. The autobiographical incident questions contain items assessing the same three time periods. Subjects are required to recall three incidents from childhood, three from early adult life, and three recent events. Three points are awarded for a correct episodic-autobiographical memory, specific in time and place. Two points are awarded for a personal but non-specific event or a specific event but time and place not recalled. One point is awarded for a vague personal memory. Zero points are given for no response or a response based on semantic memory.

The AMV is a public events questionnaire consisting of 42 open-ended questions about news events that occurred during the 70s, 80s and 90s (14 question for each decade). Examples of questions are: What happened in the primary school in Bovensmilde in May 1977? (Children were hijacked by a group of terrorists). Give the name of the square in Beijing where protesting students were massacred in 1989 (Tien An Min square or the translation of this name), Who became the first black president of South Africa in the 90s (Nelson Mandela). One point was awarded for correct answers, zero points for incorrect answers.

Gender did not have a significant effect on either test. This is important because of the gender imbalance in our samples. From normative data it appears that females have a slight benefit on the autobiographical test and males a slight benefit on the public events test, but these differences are small and not significant (Kopelman et al., 1990; Kopelman et al., 1989; Meeter et al., 2001; Meeter & Murre, 2003), and cannot be expected to affect the temporal gradient in performance.

Procedure

Both retrograde memory tests were administered during a single session at home or in the hospital. Afterwards, each spouse was asked to indicate which answers given by the patient to the questions of the AMI were correct and which incorrect. If the spouse did not know about an incident, the patient received the benefit of the doubt and points were awarded according to the criteria. The MMSE was administered during routine neurological examination by a neurologist, usually a few weeks in advance of the retrograde memory tests.

Exploratively, we examined correlations of the retrograde memory tests with two standard anterograde memory tests: the Dutch version of the California Verbal Learning Test (Verbale Leer en Geheugen Test or VLGT, Delis, Kramer, Kaplan, & Ober, 1987; Mulder, Dekker, & Dekker, 1996), and the Benton Revised Visual Retention Test (BRVRT, Benton, 1974). These tests were administered by two of the authors (E.E. and J.M.) during a neuropsychological assessment that occurred between several weeks and several months before the administration of the retrograde memory tests.

Results

Group Means

Table 1 presents the mean scores of the AD- and NC groups on both tests of retrograde amnesia. In this table the total score for the AMV is presented, as well as the scores per decade, and the total score of the AMI as well as the mean scores of the individual sections (youth, early adulthood, and recent). Two male and one female patients and one male and two female controls did not attend secondary school, and therefore did not finish the subsection on the secondary school period of the AMI. In total AMI scores, this section was therefore not taken into account. We do report the "youth" section with secondary school subsection, in order to allow comparison between AMI time periods. All data in Figures 1a and 1b, and the AMI youth period in Table 1 are thus based on data from the 18 patients and 18 controls that did finish the secondary school period. All other data in Table 1 and Figure 1c are based on the whole sample.

Differences between means were tested with the t-test for independent samples. As can be seen from Table 1, all differences between means were highly significant. The

Table 1
Mean scores on the remote memory tests for the AD- and NC group and results of tests for difference between means

Test	Max. score	AD (N = 21) Mean	AD (N = 21) SD	NC (N = 21) Mean	NC (N = 21) SD	p
AMV						
Total score	42	15.9	9.2	32.1	7.0	.00
70's	14	5.9	3.8	10.5	2.5	.00
80's	14	4.8	2.9	9.8	3.3	.00
90's	14	5.2	3.2	11.9	1.8	.00
AMI						
Total score	79*	47.5	12.2	64.5	6.4	.00
Total score personal-semantic	55*	39.3	8.6	51.1	4.1	.00
Personal-semantic childhood	21	15.3**	4.8	18.5**	2.8	.03
Personal-semantic early adult life	21	14.0	4.8	19.6	1.7	.00
Personal-semantic recent life	21	15.1	4.4	19.9	1.2	.00
Total autobiographical	24*	8.2	5.1	13.3	4.4	.00

*Excludes subsection on secondary schooling.

**Excludes 3 AD and 3 NC who did not complete the subsection on secondary schooling.

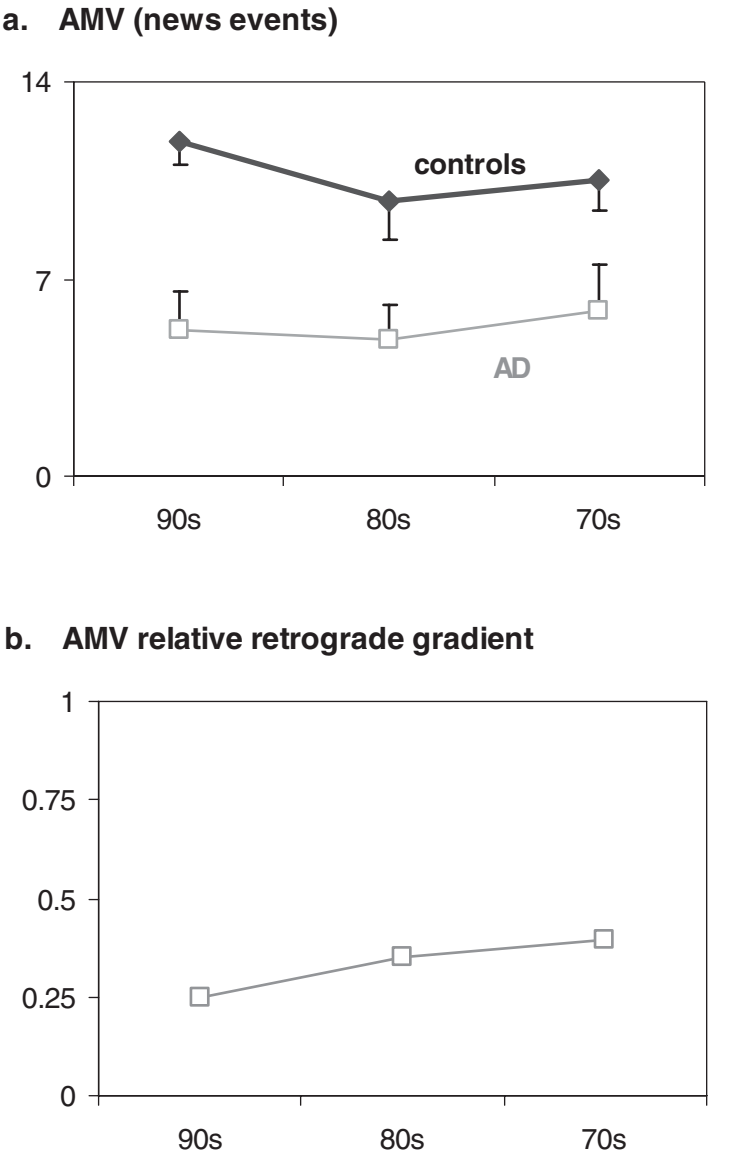

Figure 1. (a) Performance on the AMV for the patients with Alzheimer's disease (AD) and the matched controls, based on 21 controls and 21 patients, with for each mean one border of 95% confidence intervals drawn in. (b) Relative retrograde gradient computed on the basis of the data in panel *a*.

normal controls outperformed the Alzheimer group on both tests of retrograde amnesia. Both the total scores of the AMV and AMI of the AD-group were significantly below the scores of the normal control group, as were the scores for the different time periods of the AMV (70s, 80s and 90s) and the AMI (childhood, early adult life and recent life).

To explore whether there is a temporal gradient in the recollection of memories, we tested the interaction between time period and group (AD vs. NC). For the AMV there

was evidence for a gradient, $F(2,80) = 5.70$, $p = .005$, with main effects for decade, $F(2,80) = 7.79$, $p = .001$, and of group, $F(1,40) = 41.1$, $p = .004$. However, the gradient is very slight, as the mean scores of the Alzheimer group for the 70s, 80s and 90s are not far from each other (Figure 1a). For the AMI there was no temporal gradient on personal-semantic items, $F(2,68) = 1.39$, nor on the autobiographic incidents items, $F(2,80) = 1.16$, $p = .32$ (Figure 2 a-b.). There was a main effect of group on both the personal-semantic items, $F(1,34) = 26.76$, $p < 0.001$, and on the incidents items, $F(1,40) = 14.03$, $p = .001$, but no main effect of period.

To test whether the gradient on the AMV may have reflected the insidious onset of AD, we compared only the first two decades of the test, discarding the 90s period that may have been contaminated by the onset of AD. With only these two decades the gradient was not significant, $F < 1$.

We also computed the relative retrograde gradient for both tests (see Figure 1b and 2c). This gradient is given by $log(1-p_{AD})/log(1-p_C)$, where p_{AD} is the performance of the patients and p_C is the performance of the normal controls (see Murre et al., subm.; Murre et al., in press, for a rationale of this formula). For both tests the relative retrograde gradient is downward-sloping—also from the middle to the most remote period—suggesting that a nonsignificant Ribot gradient could be present in the data.

To explore whether there is a relationship between learning of new information and the recollection of old memories and knowledge, correlations were computed between both retrograde memory tests and the two anterograde memory tests. In Table 2 the Pearson correlations are presented for the Alzheimer group. In addition the correlations with the MMSE is presented.

As can been seen from this table, there is no correlation between the VLGT total correct score and both tests of retrograde amnesia. There was a correlation between the number of correctly recalled items of the Benton RVRT and the AMV total score, indicating that patients who recalled more visual patterns could recall more public events. Furthermore, MMSE scores were relatively strongly correlated with both measures of retrograde amnesia. For the interpretation of these correlations it is important to keep in mind that there were several months in between administration of the anterograde memory tests and of the retrograde memory tests.

Interestingly, there was also a significant negative correlation between our retrograde memory tests and false-positive recognition errors on the VLGT. Patients who perform worse on the retrograde memory tests thus made more false recognition errors on the verbal learning test. We inspected the AMI responses of the AD patients to explore this matter further. Spouses had verified all AMI responses generated by the patients. The proportion of answers generated that were classified as incorrect by the spouse ranged from 0% to 26% (mean: 12%). Thus, incorrect answers or false recollections to questions about one's own life are relatively common in AD patients. The AMI total score that was verified and consequently corrected correlated strongly with the unverified and uncorrected AMI total score ($r = 0.93$), which implies that verification did not change the ranking of the patients very much. This is because the number of answers that were classified as incorrect correlated only weakly ($r = 0.19$) with the number of correctly answered items. However, the number of false positive recognition errors in the VLGT turned out to correlate strongly ($r = 0.60$) with the proportion of AMI answers classified as incorrect by the spouses of the patients.

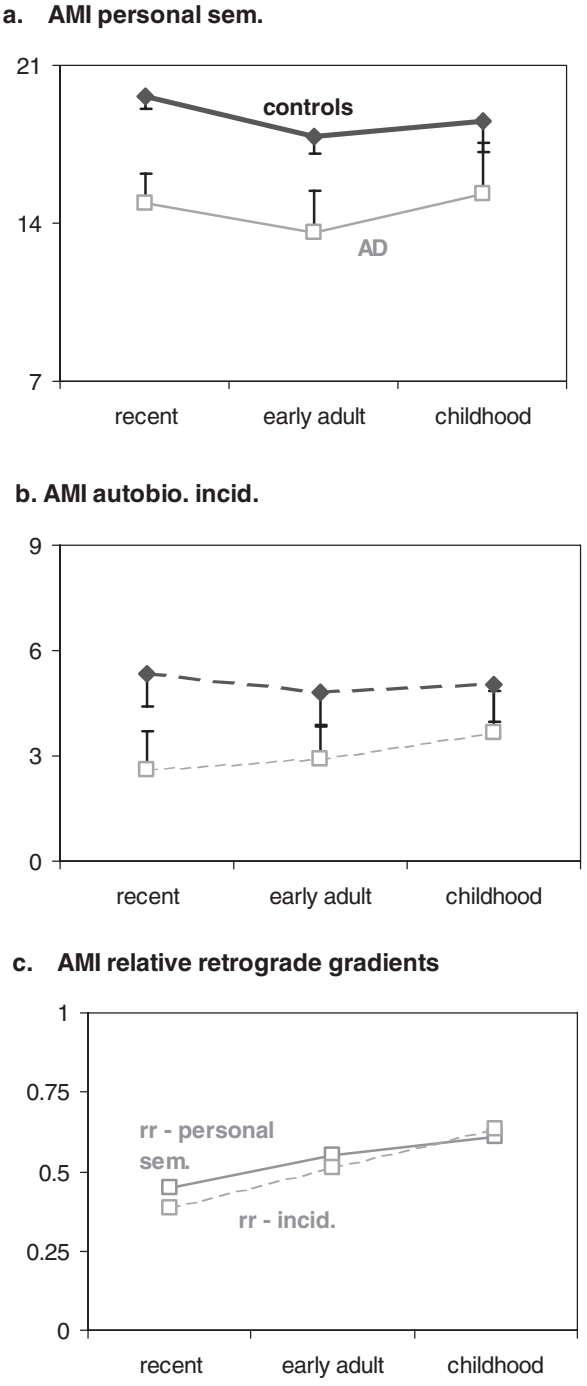

Figure 2. Performance on the AMI personal-semantic questions (a) and autobiographical incidents (b) for patients with Alzheimer's disease (AD) and matched controls. Based on data from 18 controls and 18 patients, with for each mean one border of 95% confidence intervals drawn in. (c) Relative retrograde gradient computed on the basis of the data in panels *a* and *b*.

Table 2
Correlations between retrograde memory tests and the MMSE and the anterograde memory tests in the Alzheimer group (n = 21)

Test	AMV total score	AMI total score
VLGT total correct trial 1–5	0.05	0.16
VLGT false positives recognition	–0.54**	–0.42*
Benton RVRT total correct	0.49*	0.09
Benton RVRT total errors	–0.33	–0.03
MMSE	0.46*	0.61**
AMV total score		0.53*

*Correlation significant at 0.05 level.
**Correlation significant at 0.01 level.

Discussion

As has been found in many other studies, patients with mild or moderate Alzheimer's disease exhibited substantial retrograde amnesia. They recalled considerably fewer autobiographical memories than did controls (from early childhood until present), as well as public events from the past 30 years. The results are conflicting with respect to the presence of a temporal gradient in the retrograde amnesia. In memory for public events we found a weak but significant gradient: patients recalled remote events slightly better than recent public events. In contrast, no gradient was found for the autobiographical memory.

Our diverging results are in line with the literature. Some studies did not find a Ribot gradient (Dall'Ora et al., 1989; Leplow et al., 1997; Wilson et al., 1981), while other studies found a shallow one (Beatty & Salmon, 1991; Beatty et al., 1988; Greene et al., 1995; Kopelman, 1989; Meeter et al., 2005; Piolino et al., 2003). In Table 3, we have listed all studies that provided dateable memory scores for both patients with AD and controls (the Dall'Ora et al., 1989, study did not report scores of control participants, while materials in the Beatty and Salmon, 1991, study cannot be dated with precision). All of these studies focused on patients with 'mild or moderate' AD.

Surprisingly, there is no strong relation between the kind of remote memory test used and the resulting gradient. Gradients have been found and not found in autobiographic memory, and have been found and not found with public events questionnaires. Moreover, ceiling and floor effect clearly cannot explain the conflicting results, as they seldom occur in the cited studies. In general, test characteristics are unlikely to account for these results, because Ribot gradients have been reported and not reported in studies that used exactly the same test. For the AMI, two studies (Kopelman, 1989; Meeter et al., in press) report a Ribot gradient, another found one for one subtest but not the other (Greene et al., 1995), while the current study found none with traditional analyses.

Inspection of Table 3 suggests two more points. The first is that most studies did not report on whether a Ribot gradient exists beyond the most recent period, the period most likely to be contaminated by anterograde amnesia. In both the current study and the Meeter et al. study (in press), reported Ribot gradients were not significant when the most recent period in the test was excluded. We also computed a relative retrograde gradient from the data. For almost all studies, this gradient was downward sloping also beyond the

Table 3

Studies reporting on retrograde amnesia gradients in Alzheimer's disease

Study	Kind of test	N p.	N c.	Years back	Reported gradient	>10 year?	RR-gradient >10 yr	Floor effects	Ceiling effects
Current	*public events*	*21*	*21*	*30*	*y*	*n*	*y*	*n*	*n*
	autobiogr.	*21*	*21*	*+/–60*	*n*	*n*	*y*	*n*	*n*
Beatty et al., 1988	public events	12	17	50	y		y	n	n
Greene et al., 1995	autobiogr.	33	30	+/–60	y/n**		y/n**	n	y/n**
Ivanoiu et al., 2004	autobiogr.	21	20	+/–60	y/n***		y	n	n
Kopelman, 1989	autobiogr.	8	18	+/–60	y		y	n	y/n***
Kopelman, 1989	public events	8	18	40	y		y	n	n
Leplow et al., 1997	public events	16*	16	64	n		n	y	n
Meeter et al., 2005	autobiogr.	16	15	+/–60	y	n	y	n	y
Meeter et al., 2005	semantic	16	15	30	n	n	y	n	n
Piolino et al., 2003	autobiogr.	18	13	+/–70	y		y	n	n
Wilson et al., 1981	public events	24	20	45	y		y	y	n
Wilson et al., 1981	famous faces	24	20	45	n	n	y	n	n

p = patients, c = controls. *included some patients with vascular dementia; **for episodic, not semantic items; ***for semantic items, not episodic.

Given are the kind of test, sample sizes, how long the test stretched back, whether or not a Ribot gradient in AD patients was reported by the authors, whether or not the gradient was also found excluding the most recent ten years, whether an RR gradient showed a gradient on periods more remote than 10 years, whether there were floor effects in the performance of patients (defined as performance below 10% for more than one period) or ceiling effects in the performance of controls (defined as performance above 90% for more than one period).

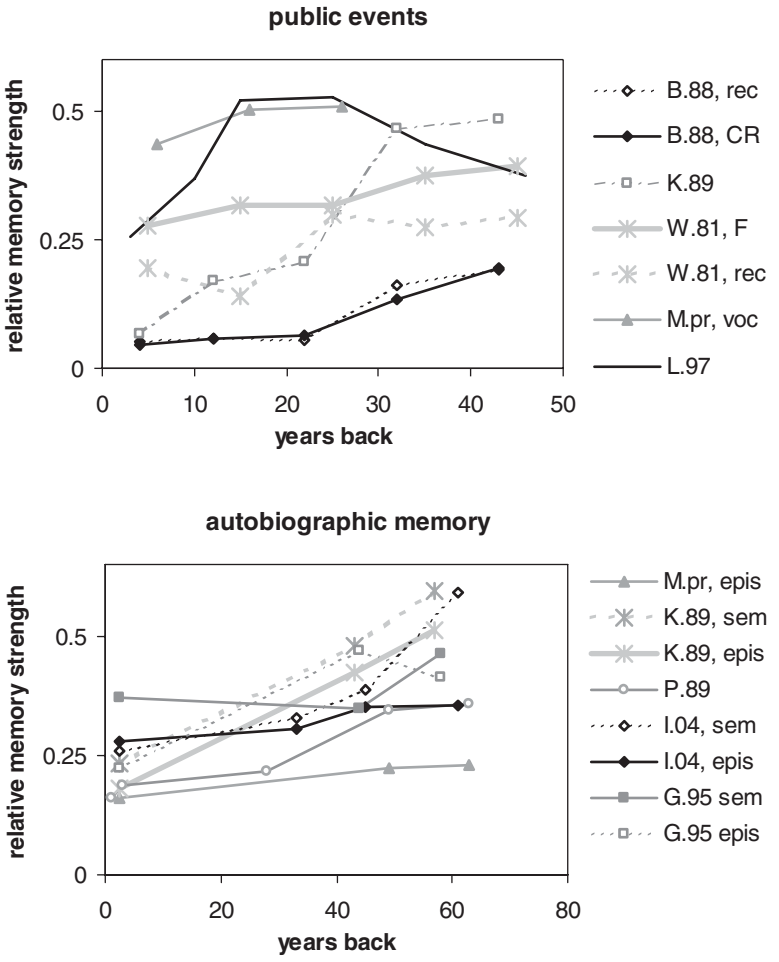

Figure 3. Relative retrograde gradient calculated from the data of published studies of retrograde amnesia in patients with Alzheimer's disease. X-axis gives the remoteness of the midpoints of the time periods, the Y-axis estimated memory strength relative to controls, B.88=Beatty et al., 1988; K.89=Kopelman, 1989; W.81=Wilson et al., 1981; M.pr=Meeter et al., in prees; L.97=Leplow et al., 1997; P.89=Piolino et al., 1989; 1.04=Ivanoiu et al., 2004; G.95=Greene et al., 1995; rec-recall, CR=cued, F-face naming; voc=vocabulary; epis=episodic events questions; sem=personal semantic questions.

most recent period[1],(See Figure 3) suggesting a Ribot gradient, which may or may not be too shallow to be detected by an ANOVA (e.g., Figure 1b and 2c).

From this we draw two tentative conclusions. First, it may be that most reported Ribot gradients only reach significance because of the weak performance of patients on the most recent period tested. This makes contamination through anterograde amnesia a viable alternative explanation for these gradients. Second, beyond this most recent period retrograde amnesia in patients with AD tends to show a shallow Ribot gradient, one too shallow to lead to a significant interaction between group and period, usually the criterion for

[1]For each study we computed a correlation between the transformed performance of the AD group and period midpoint. All except two correlations were positive (i.e., performance was better for more remote periods), resulting in an average correlation of 0.73, different from 0. $t(14) = 4.94$, $p < .001$.

establishing a gradient. However, a meta-analysis should be able to detect a gradient beyond the most recent period tested. Whether such a shallow gradient supports the consolidation hypothesis or disproves it is not clear—the proverbial half-full or half-empty glass.

Concerning the relationship between learning of new information and retrograde amnesia, no clear conclusions can be reached as administration of anterograde memory tests was several months before administration of the retrograde memory tests. It is thus all the more surprising that the number of recognition errors on the verbal learning test was inversely correlated to the performance of both retrograde memory tests. Patients who performed better on the retrograde memory tests made fewer recognition errors on the verbal learning test.

We analyzed this result more in depth by computing the percentage of incorrect answers on the autobiographical questions of the AMI in the AD group. We found that AD patients frequently produced incorrect answers (mean of 12%) to the autobiographical questions, some patients as much as 26%. Our mean percentage is higher than that reported in a British study (Kopelman et al., 1989). In that study family members were requested to verify answers. We only asked longstanding partners to perform this task, who are likely to be better informed about the events that are probed than other family members. The partners could verify almost of all of the answers (the number of verified answers was not mentioned in the British study). Verification of the answers had a sizeable influence on the total score received by the patient (this total score was lowered), which means that the amount of retrograde amnesia was underestimated if we had not verified the answers given by the patient. However, correction through verification did not lead to a different rank ordering of patients.

We should consider the possibility that the spouse is the one who is mistaken during verification of the answers of the patient. An indication for the validity of our verification process is that the proportion of rejected answers correlates highly ($r = 0.60$) with the number of false-positives on the recognition list of the verbal learning test (CVLT). As the verbal learning test was administered several months before the retrograde memory test, this suggests that there is a stable factor underlying a low threshold of response-generation from memory. This may be related to frontal dysfunction in some AD patients (indeed, Kopelman, Stanhope, & Kingsley, 1999, suggest that retrograde amnesia is related to frontal dysfunction). Unfortunately, we did not include a test of executive functioning in our battery, so this conjecture remains to be investigated.

This study shows that the assessment of retrograde amnesia can be a useful method in clinical practice to aid diagnosis of memory loss. We found that even patients with mild or moderate Alzheimer's dementia show considerable retrograde amnesia. Furthermore, verification of answers given by AD patients by their spouse is recommended when testing autobiographical memory.

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